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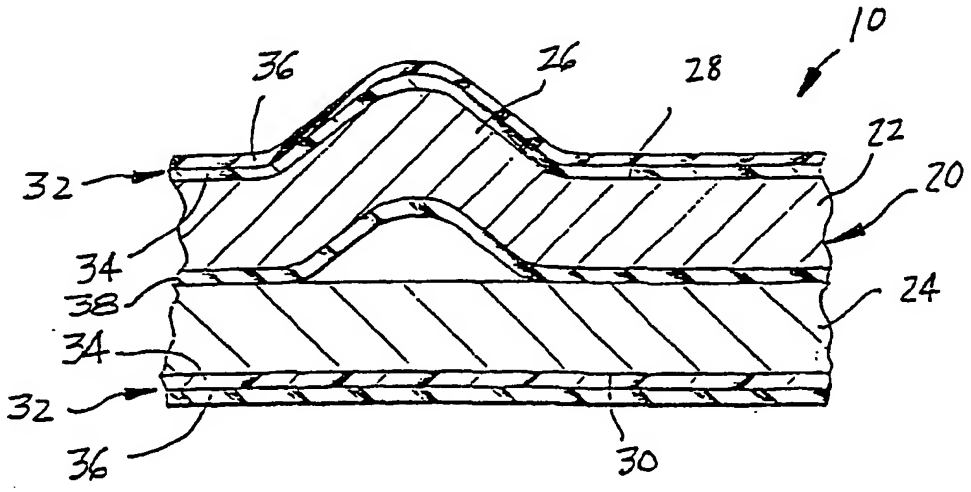
(54) Title: MLS GASKET HAVING MULTI-LAYER SEAL COATING AND METHOD OF MANUFACTURE



(57) Abstract: A multi-layer steel (MLS) gasket (10) particularly suitable as a cylinder head gasket of an internal combustion engine includes a metal gasket body (20) comprised of at least one and preferably two or more metallic plates (22, 24) that are assembled to provide a unitary structure. A multi-layer seal coating is applied to at least one and preferably both outer surfaces of the metal gasket (10), including a base layer of fluoroelastomer (34) and a top coat of NBR (36).

WO 01/02714 A1

MLS GASKET HAVING MULTI-LAYER SEAL COATING AND METHOD OF MANUFACTURE

BACKGROUND OF THE INVENTION

1. Technical Field

This invention relates generally to multi-layer metal (MLS) gaskets adapted for use in internal combustion engines as a seal between the cylinder head and block of the engine, and more particularly to the outer seal coating applied to such gaskets.

2. Related Prior Art

Multi-layer steel (MLS) gaskets are commonly installed between the block and cylinder heads of internal combustion engines to seal the various openings and passages communicating therebetween against leakage. It is conventional to provide a soft seal coating on the outer surface of MLS gaskets. The seal coating fills in any scratches or imperfections present on the mating surfaces of the heads and block and accommodates relative thermal movement that occurs between the heads and block in order to maintain a fluid-tight seal under such conditions.

A common seal coating material used for MLS gaskets is NBR. NBR is a soft, elastic, gummy nitryl polymer material that exhibits excellent sealability properties, even under extreme low temperature cold engine conditions, and is relatively inexpensive. One inherent disadvantage of NBR is that it adheres poorly to stainless steel, particularly at high temperatures and in the presence of oil or engine

coolant and in an environment where thermal motion between the heads and block is present.

U.S. patent No. 5,695,203 discusses the problems associated with the soft NBR-type coatings, namely their tendency to flow at high temperatures and in some cases peel away from the metal gasket due to their poor adhesion properties. The solution offered is to limit the application of the coating to only certain areas of the gasket. U.S. patent No. 5,150,910 discusses the same types of problems with such coatings, but offers a different solution. In this case, the soft NBR-type top coating extends across the entire surface of the gasket, but underlying the soft top coating are localized rings of very hard resin material. The hard rings encircle the openings to effectively thicken the gasket locally around the openings in order to maintain high pressure on the soft top coating to prevent the flow of the top coating layer material and thus leakage of the fluid.

U.S. patent No. 5,478,652 discloses fluoroelastomers as a candidate material for the seal coating of steel gaskets, the disclosure of which is incorporated herein by reference. While fluoroelastomers exhibit certain performance advantages that would make them desirable as MLS gasket coating materials, such as their excellent adhesion to stainless steel and resistance to heat, oil, and coolants, they are prohibitively expensive (about 10 times as costly as NBR) and exhibit poor seal conformability, particularly at extreme low temperatures. For

this reason, fluoroelastomers are not widely used as a seal coating for MLS gaskets despite certain beneficial properties they would offer.

Nowhere does the prior art teach or suggest combining NBR and fluoroelastomer materials in such a way as to provide a seal coating for metal gaskets that takes advantage of the superior properties of each material while minimizing or altogether eliminating some or all of their deficiencies. An object of the present invention is to provide such a multi-material coating.

SUMMARY OF THE INVENTION AND ADVANTAGES

A metal gasket construction is provided comprising a metal gasket body including at least one metallic plate having at least one outer surface, and a multi-layer coating applied to the outer surface including at least one fluoroelastomer layer and at least one NBR layer.

According to a further aspect of the invention, the fluoroelastomer layer is applied as a base coat to the metal gasket and the NBR layer is applied as a top coat to the fluoroelastomer layer. The multi-layer coating of the invention takes advantage of the superior properties of the fluoroelastomer and NBR materials. The hybrid takes on the excellent adhesion properties of fluoroelastomer to metal, even at high temperatures and in the presence of engine coolant and/or oil, and the low cost NBR top coat exhibits excellent adhesion to fluoroelastomer as a base coat and retains its characteristic excellent sealability even under extreme low temperature cold engine conditions.

The invention also contemplates the multi-layer coating per se and a method for making a metallic gasket comprising preparing a metal gasket body including at least one metallic plate having at least one outer surface, and applying multi-layer coating to the outer surface including a fluoroelastomer layer and an NBR layer. The method overcomes the deficiencies of the prior art and shares the advantages discussed above.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features and advantages of the present invention will become more readily appreciated when considered in connection with the following detailed description and appended drawings, wherein:

Figure 1 is a partial plan view of a cylinder head gasket constructed according to a presently preferred embodiment of the invention;

Figure 2 is an enlarged sectional view through the gasket of Figure 1; and

Figures 3 and 4 illustrate a preferred method of applying the outer coating layers to the metal gasket.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A gasket constructed according to a presently preferred embodiment of the invention is shown generally at 10 in the drawings and may comprise, for example, a cylinder head gasket having a plurality of

openings therein, including a plurality of cylinder bores 12, water holes 14, oil holes 16 and bolt holes 18 that are conventional to such gaskets. The openings provide communication between corresponding openings and the head and block for the passage of fluids therebetween and to accommodate the mounting bolts that secure the head to the block.

The gasket 10 includes a metal gasket body 20 comprised of at least one metallic plate and preferably at least two such plates assembled to provide a multi-layer metal (MLS) gasket structure. By way of illustration, Figure 2 shows a gasket 10 having an upper metal plate 22 and lower metal plate 24 that are assembled in conventional manner to provide a unitary structure. The plates 22, 24 are fabricated of a resilient material such as stainless steel, and the plates may be contoured out of their plane to provide various features, such as a bead 26 in the form of a ridge encircling one or more of the aforementioned holes to assist in sealing. The provision of such beads 26 is well known.

The term "metal gasket body " as used in the claims and the specification is meant to refer to the stage of manufacturing a metallic gasket at the point prior to receiving the outer seal coat material.

The present invention is concerned primarily with the treatment of at least one and preferably both of the outer surfaces of the metal gasket body 20, namely the upper surface 28 and the opposite lower surface 30. The surfaces 28, 30 come into contact with the mating

surfaces of the cylinder head and block, respectively, to seal the various passages that communicate therebetween against leakage.

The gasket 10 includes a multi-layer coating 32 applied to at least one and preferably both outer surfaces 28, 30 of the metal gasket body 20 and preferably to the entire area of the surfaces 28, 30. The coating 32 is comprised of at least one layer of a fluoroelastomer 34 and at least one nitrile polymer layer of NBR 36. According to a preferred construction and as illustrated in Figures 2-4, the fluoroelastomer layer 34 serves as a base or primer coat layer applied to the metal gasket body 20, and the NBR layer 36 serves as a top coat layer applied to the fluoroelastomer layer 34. The invention contemplates, however, that the layers could be reversed or multiple such layers applied.

The multi-layer coating 32 takes advantage of the beneficial properties of each material in the context of an outer coating for a metal gasket. The fluoroelastomer layer 34 exhibits excellent adhesion to stainless steel of which the plates 22, 24 are preferably made, and is highly resistant to heat, coolant, and oil, maintaining good adhesion to the gasket body 20 under such conditions, and resisting fretting (i.e., peeling away) from the body 20. The multi-layer coating 32 takes on these favorable characteristics of the fluoroelastomer material to provide a rugged, adherent, resistant coating.

The NBR material is preferably of the type commonly used as the outer seal coat for many current metal gasket applications, such as

peroxide-cured NBR including common fillers such as carbon black, etc., and suitable adhesion promoters. Partially cured to give the material a soft, tacky quality, the NBR exhibits excellent conformability and sealability with the mating surfaces of the cylinder head and block, even at extreme low temperatures, where other materials such as fluoroelastomers have difficulty conforming and sealing. The NBR material is also relatively inexpensive and, to the benefit of the present invention, exhibits excellent adhesion to the fluoroelastomer layer such that the two layers 34, 36 are inseparably bonded to one another to provide a unitary, composite multi-layer coating 32 exhibiting the beneficial properties of the fluoroelastomer base layer 34 and those of the NBR top coat layer 36.

Both the fluoroelastomer and NBR layers 34, 36 are preferably applied as thinly as practical for reasons of economics, while maintaining uniformity. According to a preferred construction, the fluoroelastomer layer 34 is applied uniformly across the entire surface area of the upper and lower surfaces, 28, 30 of the metal gasket body 20 to a substantially uniform thickness of about 0.6 mils or less, and preferably in the range of about 0.1 to 0.5 mils. The NBR layer 36 is applied coextensively with the fluoroelastomer layer 34 to likewise cover the entire upper and lower surface 28, 30. The NBR layer 36 may be applied at about the same uniform thickness or greater than that of the fluoroelastomer layer 34, and preferably in the range of about 0.4 to 0.6.

Figures 3 and 4 illustrated the preferred method of applying the multi-layer coating of the invention. Generally, the method according to the invention involves applying to at least one and preferably to both outer surfaces of a metal gasket body 20 a multi-layer seal coating 32 including a layer of fluoroelastomer 34 and a layer of NBR 36. According to a preferred method, the fluoroelastomer layer 34 is applied first as a base coat or primer coat layer and the NBR layer 36 is thereafter applied to the fluoroelastomer layer 34 to serve as a top coat layer. Conventional techniques for applying coatings to gaskets may be employed, including spraying, dipping, screen printing, and curtain coating, as illustrated in Figures 3 and 4. Figure 3 illustrates the first step in a curtain coating process wherein the uncoated metal gasket body 20 is passed beneath a falling ribbon of fluoroelastomer layer in the direction of the arrow to the right in Figure 3, whereupon a uniform thickness of the fluoroelastomer material is laid down across the entire exposed surface 28 or 30, and subsequently adheres thereto and cures to serve as the fluoroelastomer primer layer 34. Figure 4 illustrates the same technique for applying the NBR layer 36. In between steps, the fluoroelastomer layer 34 may be oven cured, as may the final multi-layer coating 32.

As shown in Figure 2, the metal gasket body 20 may include an intermediate coating layer 38 provided between the plates 22, 24. This intermediate layer 38 is preferably NBR material like that of the

top coat 36, as it is less costly than the fluoroelastomer and generally is not exposed to conditions that present problems for NBR coatings.

Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described. The invention is defined by the claims.

What is claimed is:

1. A metal gasket construction comprising:

a metal gasket body including at least one metallic plate having at least one outer surface; and

a multi-layer coating applied to said outer surface of said gasket body including at least one fluoroelastomer layer and at least one NBR layer.

2. The construction of claim 1 wherein said fluoroelastomer layer comprises a primer coat layer applied to said gasket body and said NBR layer comprises a top coat layer applied to said fluoroelastomer primer coat.

3. The construction of claim 2 wherein said fluoroelastomer primer coat and said NBR top coat are substantially coextensive.

4. The construction of claim 3 wherein said primer coat covers substantially the entire area of said outer surface of said gasket body.

5. The construction of claim 2 wherein said fluoroelastomer primer coat and said NBR top coat have predetermined thicknesses that are about equal.

6. The construction of claim 5 wherein said fluoroelastomer primer coat has a thickness of about 0.6 mils or less and said NBR top coat has a thickness of about 0.6 mils or less.

7. The construction of claim 6 wherein said thicknesses of said fluoroelastomer 0.1 to 0.5 and NBR layer are in the range of about 0.4 to 0.6 mils each.

8. The construction of claim 1 wherein said gasket includes at least two assembled metallic plates.

9. The construction of claim 8 including an intermediate NBR layer provided between said metallic plates.

10. A multi-layer steel gasket construction comprising:

a plurality of steel plates assembled to define a metal gasket body having at least one outer surface; and

a multilayer coating applied to said outer surface including a fluoroelastomer layer and an NBR layer.

11. The construction of claim 10 wherein said fluoroelastomer layer comprises a primer coat layer applied to said metallic gasket body and said NBR comprises a top coat layer applied to said fluoroelastomer primer coat layer.

12. The construction of claim 11 wherein said fluoroelastomer primer coat layer has a thickness of about 0.5 mils or less and said NBR top coat has a thickness of about 0.6 mils or less.

13. The construction of claim 12 wherein said thicknesses of said fluoroelastomer layer is in the range of about 0.1 to 0.5 mils and said NBR layer is in the range of about 0.4 to 0.6 mils each.

14. The construction of claim 10 including at least one intermediate NBR layer provided between said plates.

15. A multi-layer coating for a assembled steel gasket comprising:

a fluoroelastomer base coat layer, in combination with

an NBR top coat layer.

16. A method of making a metallic gasket comprising:

preparing a metal gasket body including at least one metallic plate having at least one outer surface; and

applying a multi-layer coating to the outer surface including a fluoroelastomer layer and an NBR layer.

17. The method of claim 16 wherein the fluoroelastomer layer is applied first to the metal gasket body as a primer coat layer and thereafter the NBR layer is applied to the fluoroelastomer layer as a top coat layer.

18. The method of claim 17 wherein both layers are applied coextensively across the outer surface.

19. The method of claim 17 wherein the layers are each applied to a thickness of about 0.6 mils or less.

20. A method of making a multi-layer steel gasket comprising:

preparing a metallic gasket body having multiple steel plates assembled to provide a unitary gasket structure having at least one outer surface to be coated;

applying a fluoroelastomer layer to the outer surface of the metallic gasket body to serve as a primer coat layer; and

applying an NBR layer to the fluoroelastomer layer to serve as a top coat layer.

FIG-1

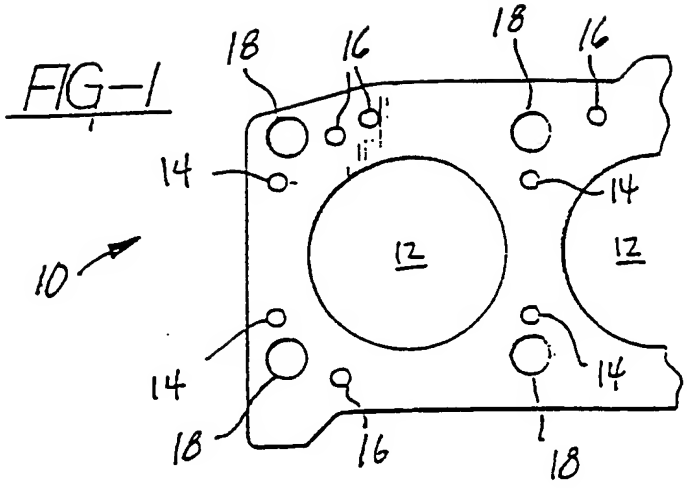


FIG-2

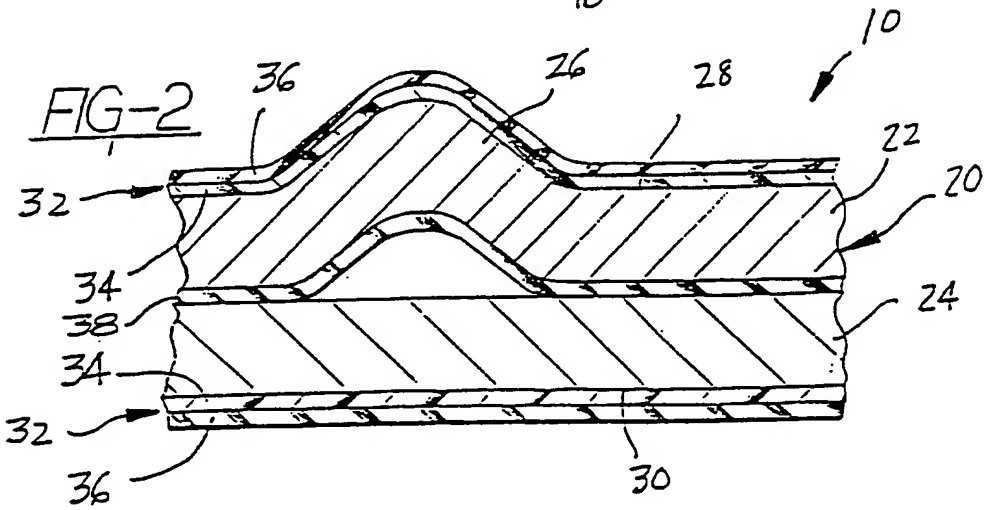


FIG-3

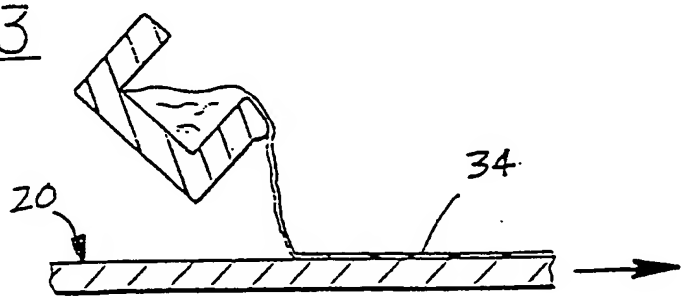
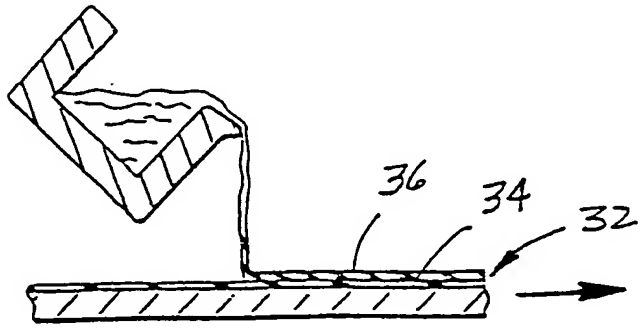


FIG-4



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/40030

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :F02F 11/00
US CL :277/592

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 277/592, 597, 945

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EAST
search terms: NBR and fluoroelastomer

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ---- Y	US 5,582,415 A (YOSHIDA et al) 10 December 1996, entire document.	1-5,8-11,14-18,20 ---------- 6,7,12,13,19
Y	US 5,150,910 A (UDAGAWA) 29 September 1992, col. 4, lines 38-42.	6,7,12,13,19

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
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"O"	document referring to an oral disclosure, use, exhibition or other means		
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